BASIC HIGHWAY DESIGN CHECKLIST

Revised December 2004

RESOURCES

- MDOT Highway Design Guide
- Maine Department of Transportation Standard Specification Book
- Department of Transportation Standard Details
- AASHTO - A Policy On Geometric Design of Highways and streets
- Project Development Process Guide
- MDOT mx manual
- MDOT Best Management Practices for Erosion and Sediment Control
- MDOT State Standards Highway Design Guide
- Highway Improvement Program Report
- AASHTO Design Procedures for New Pavements
- AASHTO Roadside Design Guide
- MDOT dictionary

This Basic Highway Design Checklist…..

- ***Is intended*** as a supplement to the Highway Design Guide and should not be used in place of it.

- ***Is Not exhaustive***

- ***Is a general progression - every project is different*** - individual judgments and preferences should be exercised within limits allowed by department policies and standards. Some design steps occur in parallel with others and a true linear progression for design really doesn't exist.

- ***Is Checklist tool*** to help guide the design process

Suggestions for improvements to this checklist are welcome and appreciated!!!

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INITIAL TEAM MEETING MILESTONE

Collect and Assemble project information
(This occurs throughout the design process - some information is needed at the beginning stages in order to determine the proper standards to use and the project scope.)

__ Highway classification
__ Aran / FWD request if necessary
__ Crash data
__ Traffic data - current year and design year
__ Posted Speed
__ Planning report
__ Project history - correspondence
__ Old plans from vault
__ Aran video - tape #
__ Geotechnical information and recommendations from geotechnical team member
__ Hydrological information
__ Projex reports
__ TIDE / TINIS reports - posted speeds / exist. Road widths / roadway history
__ Request Survey - Plot survey -Is additional survey needed?
__ If CRF is greater than 1 seek traffic evaluation and recommendation
__ If necessary, request intersection turning movements and counts
__ Wetlands information (*Environmental and Survey team members*)
__ Historic issues / impacts (4f document) (*Environmental team member*)
__ Contaminated soil information (*Environmental team member*)
__ Existing R/W widths
__ Utilities involved on the project
__ Aerial Photography

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Determine project scope - analyze the existing road see scope process in the Highway Improvement Program Report January 1997 - figure 1

__ Site review - how does the road ride?
__ Team meeting (*preferably on site*)
__ Check accident data - safety concerns
__ Check sufficiency of the existing horizontal alignment - does it meet current AASHTO standards?
- Minimum radius
- Lateral clearance -middle ordinate SSD

Use old plans or create new alignment matching the existing roadway as

__ Check existing vertical alignment - does it meet current AASHTO standards?
- SSD / HLSD
- Maximum grades

Plot existing ground profile (longsection) and use marked up triangles to do a rough check of

__ Existing Cross slopes and superelevations - are they up to standard?
__ Year built
__ Correspondence with towns - if any - check project file
__ Is it a bike route - check with the bikeways coordinator in Planning
__ Pavement condition
- Pavement management recommendation - if available
- Visual inspection (*look for degree and type of cracking and rutting*)
- FWD
- Soils data

__ Obtain Geotech recommendations
__ Is road way structurally sound?
__ Are there drainage problems?
__ ROW issues - amount of existing ROW - discuss with ROW team member
__ O.E.S. issues *(wetlands/contaminated soils / sensitive water bodies etc.)* - discuss with Environmental team member
__ Seek traffic recommendation-if needed because of:
- crash history (CRF greater than 1)
- high traffic volumes
- town requests
- intersection complications

__ Truck lane warrants
__ Signal warrants - check with traffic team member
__ Does the town want new sidewalks?

SCOPE

Safety Issues
Pavement / Soils
Drainage
Right of Way
O.E.S.-wetlands
Money

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Determine Design standards to be used

- AADT
- Posted Speed
- Design Speed - *a controlling design criterion*
- Project Scope-*New construction/Reconstruction/Rehabilitation / Overlay / 3R / 4R / State*
- Functional Class (Check Projex on computer and planning report for designation)
  Rural - Freeway / Arterial / Collector / Local
  Urban - Freeway / Arterial / Collector / Local
- NHS or non-NHS
- All projects need to be context sensitive

Consider the controlling criteria for the roadway

See chapter 3 in the Highway Design Guide for a list of controlling criteria
(*Design exceptions are required if controlling criteria cannot be met*)

Typical Section Design

- Determine travel lane width - see standards in Highway Design Guide and State Standards Design Guide - *a controlling criterion*
- Determine shoulder width - *a controlling criterion (Usually determined by aadt/roadway classification and project scope)*
- Pavement Cross Slopes (*Travel lane and shoulder*) - *travel lane cross slope is a controlling criterion*
- Darwin Pavement Design - depending on the type of project such as reclaim doing the pavement design early will allow for setting the proper vertical alignment
  - Check existing soils conditions - geotech
  - Existing gravel depth - soils explorations from geotechnical team member and or old plans from vault
  - Traffic data to determine esals (18 kip value x design year x 365 days/year = esals)
  - Use FWD data to determine resilient modulous - see geotechnical team member
  - Run Darwin pavement design to obtain pavement thickness
  - Check numbers - It would be a good idea to run the results by another experienced designer

Create Roadway Design

Horizontal Alignment - if not already created (see chapter 5 in the Highway Design Guide)

- Check minimum radius - *a controlling design criterion.*
- Check lateral clearance for the SSD - *a controlling design criterion.*
- Obtain alignments of recently built abutting projects from survey in order to match new alignment properly
- Avoid broken back curves - (*An excessively short tangent that does not allow for a proper superelevation transition between curves*)

- Determine correct superelevation rate for curves

- Review alignments with another experienced designer

Vertical Alignment (see chapter 4 in the Highway Design Guide)

- On large earthworks projects try to balance cut and fill quantities
- Maximum grades are a controlling criteria - see design guide chapter 7 and 11
- Stopping Sight Distance is a controlling criteria - see design guide chapters 7,11 and 4
  check current AASHTO standards
- Strive to achieve minimum grades for drainage purposes - ditches and curb gutters
- Look at minimum length of vertical curve
- Consider the property impacts of grade changes
- Long straight edges and triangles are valuable for setting PI's and checking existing SSD

1) Plot existing ground profile in mx the longsection LC10
2) Use triangles or other straight edges to analyze SSD for the exist. Vertical curves
3) Plot critical elevations - buildings / drives etc…
4) "Play" with PI's (*variables to use are: length of curve, PI station, and PI elevation)*
5) Run Verat file
6) Check vertical curve data particularly SSD/HLSD
7) Check impacts to: buildings / ROW / entrances / wetlands / cost /earthwork
8) Revise PI's and curve lengths in the Verat file to achieve a vertical alignment that satisfies the required design criteria.
9) Revise and Run verat file until the alignment meets the required standards and constraints.
10) Cut and plot preliminary cross sections to verify the profile will work.

> Creating preliminary design strings before cutting the sections may help in checking the impacts - also creating a file that only cuts sections at critical points such as drives saves some effort as well.

For overlay and reclaim type areas a spline grade can be created using vcusp or by amending the m string to have a certain depth over the existing ground profile (L string). This can be interspersed if necessary with the verat profile within the same input file.

Create Design Strings

- Travel lanes *(based on typical section widths)*
  Superelevation design - see chapt. 5 (*superelevation rate is a controlling criteria*)
- Design Turn lanes if needed
- Shoulders *(based on typical section widths)*
  Modify if necessary to avoid exceeding the maximum rollover rate of 8%.
- Design Islands if needed
- Create curb, guard rail, side walk and ditch strings **if** those areas are known at this time
  (See the section on template design)

Side Road Design See Highway Design Guide chapter 8 and mx design guide

- ❑ Set Horizontal Alignment
- ❑ Set Vertical Alignment (see page 8-71 in the Highway Design Guide for maximum grades approaching an intersection
- ❑ Create edge of travelway and shoulder strings
- ❑ Create Radii

- ❑ Check Radii with the design vehicles turning template(s) - Chapter 8
- ❑ Consider drainage / basin placement
- ❑ Check intersection sight distance

PRELIMINARY ALIGNMENT COMPLETE MILESTONE

Driveway/entrances design (See Highway Design Guide Chapt. 8)

- Check the applicable Access Management standards! (work with ROW and traffic team members)
- Pay particular attention to the standard details
- Do not exceed 9% grade change in 6 feet - use less than the maximum whenever possible
- Drives over 9% will be paved
- If a drive slopes down to a garage or building give it a "bump" if at all possible even if there is no curb. This will help limit water that may be channeled by snow banks in the winter from running into the entrance.
- For sharply skewed drives create an alignment and cut the long section. This will give the true grade of the existing ground to more accurately determine the correct drive slopes.
  (*Note: mx design software now allows for creating skewed cross sections)*
- On wide gravel or paved yards try to determine a consistent offset to grade to even though the drive slope may vary slightly across that width.

- In wide paved yards islands may be used to control access for safety. (See the Design Guide for maximum opening widths)

Cross Section Template Design

☛ **(Throughout the design process be thinking about drainage and drainage outlets)**

Determine Curb Areas

Used for:
- ◈ Delineating the roadway from abutting properties in urban situations
- ◈ Channels roadway water to suitable outlets - used with catch basins and or downspouts
- ◈ Prevents edge erosion in cut situations where ditches are not practical
- ◈ Sometimes used in conjunction with Guard Rail on the low side of superelevated curves - minimizes erosion
- ◈ Used to reduce slope (ROW) impacts in tight situations
- ◈ Used to create islands / control access
- ◈ Used to delineate sidewalks

Types of curb: **Bituminous type 3**

Mold 1 - barrier curb - used with sidewalks on low speed roads (*40 mph and under*) See MDOT Highway design guide chapt. 6

Mold 2 - mountable - generally used in non-sidewalk areas. For higher speed roads (*45 mph and higher*) curb should be installed so that the reveal does not exceed 6 inches on state highways and so that it does not exceed 4 inches on National Highway System roads

In general curb should be avoided if practical on high speed roads!

☛ **NOTE!**(*When mountable curb is used the clear zone offset is **not** reduced!!*)

Granite

Type 1 - barrier curb - used with sidewalks and non sidewalk areas - low speed roads only- higher traffic volumes - more durable than bituminous

Type 5 - sloped - mountable - usually used for traffic islands in higher volume urban areas

Other considerations:

- Use a 1:6 slope or flatter behind curb in fill situations to provide adequate support **or** create a 3 to 5 ft. shelf behind the curb (if there is no sidewalk) then 1:3 or flatter.
- In cut areas try to maintain a 3 to5 ft. "shelf" with a 6% slope behind the curb for snow storage

- Longer runs of curb generally will require catch basins and underdrain and possibly downspouts. Short runs of curb may not require catch basins or underdrain
- Check gutter grades to allow for proper drainage - min. gutter grade is 0.5 %
- On the high side of superelevations where there is curb it may necessary to provide a small swale ditch to intercept side slope sheet flow runoff

Determine Ditch Areas

- Allows drainage from the road way base
- Intercepts side slope drainage preventing its entrance into the roadway base
- Min. grade is 0.5 %
- Usually the depth of the ditch below subgrade should be at least 12 inches
- Sometimes when berm ditches or other shallow ditches are required underdrain may be needed as well
- Plan for erosion control
- Create ditch strings in mx
- Consider using rounded ditches in lawn areas

Guard Rail

Existing Guard Rail

- ✓ Refer to latest Guardrail Policy applicable to the type of road for upgrade discussion
- ✓ Check length of need - See Design Guide chapter 10
- ✓ Check condition - Can it be reset? / Does it need to be modified?
- ✓ Do the terminal ends need to be upgraded?
- ✓ Can the slopes be flattened and the Guard Rail eliminated?
  - ▪Consider Safety
  - ▪Consider ROW impacts
  - ▪Consider wetland impacts
  - ▪Max. fill height allowed without guard rail

See Design Guide Table 6-1 for discussion of fill slopes and fill height

New Guard Rail

- → Remember guardrail is a last resort - consider ways to eliminate need for it.
- → Determine point of hazard
- → Determine length of need (distance beyond point of hazard).
- → Use sound engineering judgment before making final recommendation.

➥ Refer to Design Guide Chapter 10 for discussion of:

- Point of hazard (obstacles within clear zone, steep slopes, embankment height etc.)
- Length of need (different methods required for different situations)
- Acceptable offset and other location issues
- Bridge approach rails
- Median guardrail

Guardrail End Treatments

- NCHRP 350 end treatments to be used on NHS and non-NHS

- Refer to latest Guardrail Policy for accepted NCHRP 350 systems and other changes.

- Refer to Design Guide Chapter 10 for a discussion of alternate end treatment types that may be used.

Create Slope Lines (Cuts / Fills) *see applicable standards in design guide(s) - see chapter on cross section elements*

Consider drainage - Don't trap water / Outlets
Some typical slopes used are: 1:4 (1 vert. /4 hor.) recoverable in- slope
1:3 (1 vert. /3 hor.) non- recoverable in- slope
1:2 (1 vert. /2 hor.) guard rail slopes and ditch backslopes and in some other cut situations such as behind sidewalks or in conjunction with a berm behind curb

Other Design components

- Sidewalks
- Retaining Walls- If necessary to match slopes see geotechnical team member for advice and design
- Clear zone issues
- Tree removal - consider possible replacement (check with landscaping unit)
- Truck Lanes
- By-pass lanes
- Exclusive turn lanes
- Island Design
- Signal requirements / Cross walk locations – Check with Traffic team member
- Landscaping elements such as shrubs and trees
  - Check with landscaping unit
  - Consider project budget
  - Ensure proposed landscaping does not obstruct sight distance

READY FOR FINAL DESIGN MILESTONE

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Drainage Design (Design Guide chapter 12)

Drainage Design Sequence

Check with maintenance division for pipe performance history or othe drainage problems.

I. Locate
- Catch Basins
- Outlets
- Stub Inlets
- Drainage runs

II. Request Drainage Study *(Provide contour roll plots / cross sections / Catch Basin and Pipe locations)*

III. Identify potential utility conflicts and get additional information - try to resolve

IV. Number Catch Basins *(Optional - some in construction like it)*

V. Determine Flowlines (*work back from outlet elevations*)

VI. Determine Flows for pipes using drainage procedures in chapt. 12 Design guide (*work from high elevations towards lower elevations*)

VII. Determine pipe sizes using drainage procedures in chapt. 12 Design guide

VIII. Check gutter spread if deemed necessary

IX. Request test pits if necessary in order to resolve conflicts.

X. Determine the correct BMP standards to be used for erosion and stabilization - See MDOT Best Management Practices Manual and environmental team member

Drainage change checklist

___ Drawing details on cross sections

___ Drawing details on plan sheets

___ Construction note sheet

___ Construction notes on cross sections

___ Estimate comps
- Drainage items
- Structural Excavation
- Gravel Estimate
- Earthwork Summary

___ Estimate Form
___ Estimator
___ Quantity Sheet

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___ Drainage Sheet

Geometrics-Curb Layout **-** required for granite curb

Erosion Control **-** See BMP manual

Final Project checklist **-** See Highway Design Guide Chapter 1

Preliminary Field Inspection

- ⇨ How does project ride?
- ⇨ Look at pavement condition - what kind of deterioration if any
  - Areas of rutting
  - Areas of cracking - what type and how bad
- ⇨ Existing shoulder condition
- ⇨ Check for obvious horizontal and vertical alignment problems
- ⇨ Check side road alignments where they connect to the main road
- ⇨ Check intersection sight distance
- ⇨ Look for obvious drainage problems
- ⇨ Note wetland areas
- ⇨ Check condition of existing drainage structures and verify size noted on plans (culverts / catch basins / box culverts) *Replace? Extend? Eliminate? Change location?* CB's *Rebuild/Alter/Adjust/Replace?*
- ⇨ Culvert outlet ditches
- ⇨ What condition is the curb in?
- ⇨ Are pedestrian ramps needed?
- ⇨ Note areas of erosion relating to the roadway
- ⇨ Is ditching needed?
- ⇨ Note condition of existing ditches
- ⇨ Are there buildings close to the road?
- ⇨ Are islands needed? Consider Access Management standards
- ⇨ Note unusually steep drives
- ⇨ Is tree trimming needed
- ⇨ Roadside safety
  - ❖ Are there hazards (DFO's) within the clear zone area? - trees / large rocks /ledge / poles etc…
  - ❖ Are there dangerous embankments or structures requiring new guard rail?
  - ❖ Existing Guard Rail

Field Inspection Supplies

Safety vest
Half size / full size plans
Marking pens
Camera / film
Folding rule
Measuring tape
Scale
Hard Hat - *if in construction site*
Steel Toes - *if in construction site*

- ❖ Invite project Team
- ❖ Maintenance representative
- ❖ Town representative (Optional)

- Check point of need - See Design Guide chapter 10
- Check condition - Can it be reset? / Does it need to be modified? / replaced?
- Do the terminal ends need to be upgraded?
- Can the slopes be flattened and the Guard Rail eliminated?
  - Consider ROW impacts
  - Consider wetland impacts
  - Max. fill height allowed without guard rail

⇨ Check for additional survey needs

Final Field Inspection

____ Check plans with field conditions
____ See how slopes match - what impacts - drainage problems
____ Check entrances
____ Verify island locations
____ Check wheel chair ramp locations
____ Look for possible water problems
____ Check proposed drainage outlets and locations of all drainage structures
____ Check DFO's within slope lines
____ Verify proposed Guardrail locations
____ Check slope grading around buildings and other sensitive areas
____ Note areas for the different types of seeding
____ Note special erosion control needs
____ Check for utility problems - with utility team member
____ Verify project limits
____ Verify curb locations
____ Check clearing locations
____ Note locations of cellar drains

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Construction Notes

Work items that are typically covered by construction notes.

___ Tree removal
___ Stump removal
___ Clearing areas
___ Remove and Reset fence
___ New fence items
___ Remove and Reset Stone Wall
___ Drainage Items
    ___ Remove existing Catch Basins
    ___ Manholes & Catch Basins
    ___ Altering Manholes or Catch Basins
    ___ Adjusting Manholes or Catch Basins to grade
    ___ Culverts
    ___ Extending culverts
    ___ Underdrain
    ___ Underdrain Outlets
___ Entrances
    ___ Paved entrances
    ___ Gravel entrances
    ___ Field / woods entrances
    ___ Crushed Stone Entrances
___ Conrete walks
___ Paved walks
___ Concrete Steps
___ Pedestrian ramps
___ Curb items
___ Reset Curb
___ Ditching
___ Landscaping Items
___ Retaining walls
___ Guard Rail Items
___ Table of Superelevation
___ Permanent Erosion Control Items
    ___ Riprap Downspouts
    ___ Culvert End Protection (riprap)
    ___ Riprap Aprons
    ___ Erosion Control blanket
    ___ Stone Ditch Protection
___ Numerous oddball notes covering unique or unusual situations

General Notes

A list of standard general notes can be found in the Highway design guide chapter 2 as well as on the W drive under MDOT microstation utilities / Spreadsheets and notes.

These notes may need to be modified for a special situation on a given project.

In addition to existing notes, new general notes may need to be written to cover unique conditions on a specific project.

Typical Plan Package Components

___ Title Sheet
___ Typical Section Sheet

Review required specifications and special provisions

Assemble PS&E

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___ Quantity Sheet / Earth Summary
___ General Notes
___ Special Details (If any)
___ Construction Notes
___ Geometric sheets (used for granite curb layout and geometrically complex jobs)
___ Profile Sheets
___ Plan Sheets
___ Cross Section Sheets
___ ROW maps

PLAN IMPACTS COMPLETE MILESTONE